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The following Table shows the progress and present state of the Society with respect to the number of Fellows :—

	Patron and Royal.	Foreign.	Having com- pounded.	Paying £2 12s. annually.	Paying £4 annually.	Total.
November 30, 1864.	6	49	320	3	276	654
Since elected	+ 1	.....	+ 9	.....	+ 10	+ 20
Since deceased	— 1	— 2	— 20	.....	— 10	— 33
Since withdrawn . .	.....	.....	.....	.....	— 1	— 1
Since defaulter . . . .	.....	.....	.....	.....	— 1	— 1
November 30, 1865.	6	47	309	3	274	639

Further Correspondence between the Board of Trade and the Royal Society, in reference to the Magnetism of Ships, and the Meteorological Department*.

Mr. Farrer to General Sabine.

“ Board of Trade, Whitehall, 25th July, 1865.

“ SIR,—I am directed by the Lords of the Committee of Privy Council for Trade to acknowledge the receipt of your letter of the 25th May, and its inclosed Memorandum, calling attention to the subject of the adjustment of compasses in iron vessels.

“The Memorandum states that the subject of the deviation of compasses is one which has hitherto been regarded as too intricate and obscure to be made the subject of practical rules for seafaring men, but that recent experience has placed the science on a sound basis, and has made it possible to frame rules which there will be no practical difficulty in applying.

“The Memorandum further intimates what those rules should be with respect to the placing and adjustment of compasses, and suggests that measures should be taken by the Board of Trade to enforce their observance. It also suggests that steps should be taken to compel Merchant Officers to become acquainted with them; and finally recommends that for the accomplishment of these purposes an Officer should be appointed, whose duty it should be, in communication with the Compass Department of the Admiralty, to aid the Board of Trade in carrying it into effect.

* Published by order of the Council.

“The Board of Trade desire me in reply to return their thanks to the Royal Society for calling attention to a subject which is of first-rate importance to the Mercantile Marine. They have no doubt that the present practice is far from satisfactory; nor do they think that the steps taken by the Board of Trade under the provisions of existing Acts are such as to remedy the evil. At the same time they can see considerable difficulty in adopting all the suggestions made by the Royal Society.

“The steps which the Board of Trade now take are as follows:—

“The Merchant Shipping Act provides that the compasses of passenger steamers shall be adjusted to the satisfaction of the Board of Trade Surveyors, and according to regulations laid down by the Board of Trade. This duty the Surveyors do as well as the means at their disposal enable them to do, and according to regulations which will be found in paragraphs 83 to 86 of the accompanying ‘Instructions to Surveyors.’

“As regards the information of Masters and Mates, the Board of Trade have circulated a pamphlet, prepared by Mr. Towson, of Liverpool, which is, no doubt, known to the Royal Society, and have added a general question on the subject to the Examination-papers.

“Under these circumstances it is to be considered whether the Board of Trade can, and whether, if they can, they ought to do more than they do either as regards the proper supply and adjustment of compasses, or as regards the diffusion of information on the subject.

“As regards the first of these points, viz. the proper supply and adjustment of compasses, the Royal Society will, no doubt, concur with the Board of Trade in thinking that it is very undesirable for the Legislature or the Government, except under very exceptional circumstances, to take upon themselves responsibilities which properly belong to shipowners and insurers, or to dictate to those persons the mode in which they shall carry on their business. The proper supply and adjustment of compasses is a matter so material to the safety and success of their undertakings, that motives of self-interest are likely to effect much greater and much better results than could be hoped for by the compulsory interference of a Government Department. These considerations will have to be very carefully weighed before any attempt is made to obtain from the Legislature further powers for the regulation of compasses in merchant ships. And under the law, as it now stands, the Board of Trade do not see what effectual step they can take in the direction pointed out by the Royal Society.

“In the first place, the powers under which they act only apply to passenger steamers, whilst the want which the Royal Society wish to meet is felt just as much in the case of other iron vessels, which are becoming more numerous every day.

“In the second place, the powers of the Board of Trade only extend to obtaining a Certificate ‘that the compasses have been properly adjusted.’ They do not enable the Board of Trade or its Officers to see that the compasses are good, or to require—what the Royal Society appears to consider

the most important condition of all—that there should be a Standard Compass (in addition to the Steering Compass) so placed as to be free from local attraction.

“This Board cannot, therefore, do what is wanted under the present Acts.

“There is, however, a body, namely, Lloyd’s Register Committee, whose proper business it is to see that ships classed by them are seaworthy, and My Lords will refer this part of the subject to them, stating what they hear upon the subject from the Royal Society. This Board will also gladly communicate to Lloyd’s any practical rules which the Royal Society can furnish as to the supply, placing, and adjustment of compasses, and as to the effect upon them of different modes of construction of the hull of the ship.

“Secondly. As regards the diffusion of information on the subject of compasses, especially among Merchant Officers, the first desideratum appears to be a clear and intelligible Manual or set of directions upon the subject, containing such practical rules as the present state of Science can furnish, and such a statement of the principles as may be necessary for the comprehension of those rules. My Lords will be glad to be informed by the Royal Society if they can put them in the way of obtaining such a Manual. Any expense connected with its preparation will be readily defrayed by the Board of Trade.

“The next step to be taken would be to introduce the subject into places of nautical education. On this the Board of Trade can do nothing except communicate with the Science and Art Department, which they will gladly do on hearing from the Royal Society that such a Manual as above mentioned is in preparation.

“The third step would be to introduce the subject more effectually into Examinations in Navigation, and to have printed questions prepared for the purpose. On this point also the Board of Trade would be glad to know whether the Royal Society can give them information or assistance. One difficulty which will arise will be the difficulty in finding Examiners who have given sufficient attention to the subject, and the first step must probably be to instruct the Examiners themselves. For this purpose also the suggested Manual will be of great importance.

“The steps suggested above may be taken with the aid of the Royal Society, without any such appointment by the Board of Trade of an additional officer as the Royal Society suggest.

“This disposes of most of the important points referred to. There are two which still require notice. The Royal Society propose that the suggested new Officer of the Board of Trade shall assist at inquiries into wrecks, where questions arise concerning the deviation of the compass. Though the Board of Trade are not prepared to appoint a special officer for this purpose, or to commit the inquiry to such an officer, they think that it would be very useful if, in the cases of future inquiries into

wrecks, where important questions concerning compasses are likely to be raised, a person thoroughly acquainted with the subject could attend and give the Court the benefit of his opinion. On this subject the Board will communicate with the Admiralty.

“Lastly, the Royal Society refer to the possible improvement of the science by means of further observations. As regards this, all the Board of Trade could do would be to obtain observations from Masters of merchant ships, in the manner originally proposed by the Royal Society, when the Meteorological Department of this office was established. The whole subject of that department is now under consideration, and this branch of the subject of the Royal Society’s letter will be considered in connexion with the rest of that department.

“I have the honour to be,

“Sir,

“Your obedient Servant,

“T. H. FARRER.”

“Major-General Sabine, &c. &c. &c.,
President Royal Society.”

Mr. Fane to General Sabine.

“Board of Trade, Whitehall,
12th August, 1865.

“SIR,—I am directed by the Lords of the Committee of Privy Council for Trade to forward to you the inclosed copy of a letter received from the Secretary to Lloyd’s Register, in answer to a communication from this Board relative to the subject of Compasses in Iron Ships.

“I am, Sir,

“Your obedient Servant,

“Major-General Sabine, &c. &c. &c.,
President Royal Society.”

“W. S. FANE.”

(Inclosure.)

“Lloyd’s Register of British and Foreign Shipping,
2 White Lion Court, Cornhill, 4th August, 1865.

“SIR,—I am directed to acknowledge the receipt of your letter dated 25th ultimo, with its inclosures, relating to the variation &c. of Compasses in Iron Ships, and to acquaint you that it occupied the attention of the Committee of this Society at their Meeting yesterday.

“It appears that it is a subject encompassed with difficulties, and that but little is known at present as to any method which shall ensure satisfactory action of compasses in iron vessels.

“The Committee apprehend therefore that it will not be in their power to take any active steps in the matter; but they will avail themselves of such means as are at their disposal to obtain information on the important

subject thus brought under their notice, and will apprise the Board of Trade Authorities of the result of their inquiries.

"I am, &c.,

(Signed)

"GEO. B. SEYFANG,

"Secretary."

"T. H. Farrer, Esq.,
Secretary, Board of Trade, London."

General Sabine to Mr. Farrer.

"Llandovery, S. Wales, Aug. 28th, 1865.

"SIR,—I beg to acknowledge the receipt of your letter (3027W) of the 12th inst., enclosing copy of a letter received from the Secretary to Lloyd's Register. They shall be duly laid before the Council of the Royal Society, together with your previous letter, at the first Meeting after the recess.

"From inquiries which I have made I have reason to believe that when the proper time shall come a Manual, such as you have referred to, for the instruction and guidance of the builders, fitters, and navigators of the iron ships employed in conveying passengers and merchandize, might be supplied by persons whose sound and practical knowledge qualify them eminently for rendering such a public service; but a work which should satisfy all the requirements referred to in your letter cannot be prepared until the system to be adopted in the Mercantile Marine shall have been, to some extent at least, determined, and then not without the concurrence of the person or persons who should be charged with bringing the system into practical operation.

"The success which has attended the steps taken by the Board of Admiralty to remedy the evils resulting from the disturbance of the compass in Her Majesty's Ships at a time when the science was in a comparatively rudimentary state, is owing to the combination of a proper code of instructions with arrangements for their enforcement under official and competent superintendence, and may be advantageously referred to as a precedent should the Board be disposed to adopt a similar proceeding.

"I have the honour to be, Sir,

"Your obedient Servant,

"T. H. Farrer, Esq."

"EDWARD SABINE."

Mr. Farrer to General Sabine.

"Board of Trade, Whitehall, 23rd October, 1865.

"SIR,—I am directed by the Board of Trade to acknowledge the receipt of your letter of the 28th August relative to the preparation of a Manual for the guidance and instruction of persons employed in the construction and navigation of iron ships.

"In reply, I am to thank you for your communication, and to observe that the object of this Board, in proposing a Manual of this kind, was, in

the first and chief place, to place in the hands of those interested in shipping, the means of making themselves acquainted with the results of recent observation, which the Royal Society say can now be made available in practice, and the Board of Trade supposed, and still hope, that this may be done without involving the necessity of Government interference with, and supervision over, the Mercantile Marine.

“ I have the honour to be, Sir,

“ Your obedient Servant,

“ *Major-General Sabine, &c. &c. &c.,*
President Royal Society.”

“ T. H. FARRER.”

Mr. Farrer to General Sabine.

“ Office of Committee of Privy Council for Trade,
 Whitehall, 24th October, 1865.

“ SIR,—I am directed by the Lords of the Committee of Privy Council for Trade, to acknowledge the receipt of your letter of the 15th June last, on the subject of the Meteorological Department of the Board of Trade, and to thank yourself and the Council of the Royal Society for the valuable information, advice, and suggestions which it contains.

“ The Council of the Royal Society discuss the system of Weather Telegraphy, and recommend that it shall be continued; they approve of the proposal to hand over to the Hydrographer to the Admiralty such part of the observations collected in the Meteorological Department of the Board of Trade as he can make use of in constructing Charts for the use of seafaring men. And they discuss and recommend the adoption of a new system of making and recording Meteorological Observations on land.

“ As regards, however, one branch of the subject, viz. Meteorological Observations made at sea, which formed the original object of the Meteorological Department, and the chief subject of the letter from the Royal Society of the 22nd February, 1855, the Board of Trade are not satisfied that they fully understand the present views of the Royal Society.

“ Your letter says in answer to Question 1, contained in my letter of the 26th May last, asking ‘ Are the objects specified in the Royal Society’s letter of the 22nd February, 1855, still as important for the interests of Science and Navigation as they were then considered?’ that ‘ The President and Council are of opinion that the objects specified in the Royal Society’s letter of 22nd February, 1855, are as important for the interests of Science as they were then considered.’

“ And it further says in answer to Question 2, asking ‘ To what extent have any of these objects been answered by what has already been done by the Meteorological Department?’ that ‘ Much has without doubt been accomplished in the collection of facts bearing on Marine Meteorology; but as no systematic publication of the results has yet been made, the President and Council are unable to reply more specifically.’ It is probably for the reasons contained in this answer, that whilst the other sub-

jects above mentioned are fully discussed in your letter, the subject of these Meteorological Observations at sea is scarcely referred to.

"It is, however, essential that the Board of Trade should be rightly informed upon this point before they can determine what steps should be taken with regard to the Meteorological Department. What is the value of the Observations at sea already collected? what steps should be taken to make them useful? and whether any, and, if any, what further observations of the same kind should be collected, are questions which must be answered before any final arrangement can be made with respect to the other points mentioned in your letter. With the view of clearing up these points, the Board of Trade are disposed to suggest the appointment of a small Committee, consisting, say of three or four persons, to examine the whole of the data already collected by the Meteorological Department; to inquire whether any, and what steps should be taken for digesting and publishing them; and also to report whether it is desirable that observations of a similar kind shall still continue to be collected. Such a Committee would also in all probability be able to make valuable recommendations as to the mode in which the business of the Department (if continued) shall be conducted, and as to the form in which the daily weather reports (by whomsoever they may be made) should be published.

"If the Royal Society concur in this suggestion, the Board of Trade would ask them to appoint, as a member of the Committee, some gentleman whose acquirements would enable him to give valuable advice on the scientific part of the subject, and they would also ask the Admiralty to appoint another member. The Board of Trade will feel much obliged if you will favour them with the opinion of the President and Council on this suggestion.

"With reference to the subject of Meteorological Observations on land, the Board of Trade do not clearly understand whether the Royal Society think that they should be substituted for, or be in addition to the Meteorological Observations at sea, which were originally suggested by the Royal Society. They are disposed to agree with the Royal Society in thinking that any observations of a scientific nature would be better conducted under the authority and supervision of a scientific body such as the Royal Society, or the British Association, than of a Government Department. But they do not see how they could advise the Government to sanction any plan which would involve the establishment of two separate Offices for Meteorological purposes, one under the Board of Trade at Whitehall, and the other at Kew. It seems to them obvious that any assistance to be given by Parliament for Meteorological purposes will be more advantageously employed if concentrated at one place, and in one set of hands, than it can be if distributed among different Establishments.

"I have the honour to be, Sir,

"Your most obedient Servant,

"The President of the Royal Society."

"T. H. FARRER."

Staff-Commander Evans, R.N., to General Sabine.

“Hydrographic Office, October 23rd, 1865.

“MY DEAR SIR,—I have forwarded to Burlington House for your acceptance, a copy of my letter of suggestions relative to iron ships and their compasses, drawn up for the Board of Trade.

“I gathered from a recent conversation that you were desirous of having this document, with the possible view of showing it to the Council of the Royal Society. I hope it may be found useful, as supplementary to your and their labours.”

“I am, my dear Sir,

“Yours very faithfully,

“General Sabine, &c. &c. &c.”

“FRED. JNO. EVANS.”

*Copy of Letter, with Appendices, from Staff-Commander Evans, R.N.,
to the Hydrographer of the Admiralty.*

“Admiralty, Hydrographic Department, September 1865.

“SIR,—Having carefully examined the correspondence between the President and Council of the Royal Society and the Board of Trade on the Magnetism of Ships, together with the Memorandum appended to the President’s letter of the 18th May, and having also considered the requisitions made by the Board of Trade to the Admiralty, by letter of the 28th July, 1865, to be furnished through the Compass Department with any information or suggestions on the subject, I have to submit the following for your consideration.

“The Memorandum of the Royal Society is so comprehensive in its general views of the subject, that little remains to be added to the arguments and reasons therein advanced; but in those matters of detail which would require attention in the event of action being taken on the recommendations of that body, there are several suggestions which present themselves, and which possibly may be useful to the Board of Trade. To these I address myself.

“To clearly understand the existing difference of administration, in compass-equipment and efficiency, between the Royal and Mercantile Marine, it is necessary to point out the views the Board of Admiralty entertained, and the steps they deemed it necessary to take on the introduction of steam machinery, and of so much iron in the general construction of ships of the Royal Navy.

“Passing over the investigations successively made under their auspices by Flinders in 1814, Barlow in 1821, and Johnson in 1836 the Admiralty in 1837, ‘deeming it necessary to apply some remedy to an evil so pregnant with mischief,’ referring to the then defective state of the compasses supplied to Her Majesty’s ships, ‘have determined to have the subject fully investigated by a Committee of Officers conversant with magnetic instruments.’ Resulting from the labours of this Committee, which extended

over several years, was not only the improvement of the compass itself, but the establishment of a system of compass-adjustment which has since been uniformly followed in Her Majesty's Navy.

"The principal features of this system are the following:—

"1. The having in each ship a standard compass distinct from the steering-compass, fixed in a position selected, not for the convenience of the helmsman, but for the moderate and uniform amount of the deviation at and around it, by which compass alone the ship is navigated.

"2. The requiring each ship to be swung, and to be navigated by a Table of Errors.

"The Admiralty further at this period (1842), to ensure the proper manufacture and adjustment of the standard compass, especially the selection of its position in the ship, and the general supervision of the 'swinging' of the ships of the Fleet, created a small Compass Department, and erected an Observatory and offices for the general examination of all the compasses supplied to Her Majesty's ships. As a matter of opinion, I may here express my belief that indirectly this latter establishment has tended very much to the improvement of compasses generally.

"The Admiralty at this time also issued a small book of Rules, known as the 'Practical Rules' for ascertaining and applying the deviations of the compass; these Rules have undergone revision and addition from time to time. (The latest edition is appended.)

"General rules were also now laid down for guarding, in the equipment of the ship, against the near proximity of iron to the compass: extracts embracing the leading features of these Rules will be found in Appendix 1.

"In 1862, consequent on the increased use of iron in the construction and armature of ships of war, there was issued for the service of the Fleet, the 'Admiralty Manual of the Deviations of the Compass,' a work which, incorporating also the 'Practical Rules,' placed within the reach of the educated seaman the theory and general principles of the magnetism of ships, as also so much of the elements of terrestrial magnetism as affected the navigator.

"In the Mercantile Marine, regulations for the examination and adjustment of the compasses are confined to sea-going passenger steamers. I gather from the letter of the Board of Trade, in reply to the Royal Society, as indeed I am aware from general personal knowledge, that practically, except perhaps in the larger shipping companies, these regulations are inoperative, or nearly so.

"For example, there are no prescribed rules as to the number, the position, or the efficiency of the compasses, and there is no guarantee for the competency of the adjuster, in whose hands the whole arrangements are generally placed. In many ports, and especially that of London, there is inefficient provision for swinging the ships.

"It appears unnecessary to remark, after what has just been briefly

stated, that the system adopted to ensure security of navigation in the Royal Navy has no counterpart in the Mercantile Marine. The assimilation in practice of the two services, so far as relates to the more essential points, would certainly be a desirable end to attain.

“I have already briefly detailed the two leading features of the Admiralty system:—The *first* of these (the navigating the ship by a standard compass) is in itself so simple, and has proved in practice so secure, and the neglect of it in many cases in merchant ships has been followed by such disastrous consequences, that I conceive there is no question that it should be enforced wherever there are the means of enforcement. Indeed, were it rendered imperative by law, that *every* vessel making a long sea voyage, and *every iron* vessel, whether employed coasting or foreign, should be fitted with a standard compass, I am of opinion this measure would not only directly tend to their secure navigation, but would indirectly tend to foster that knowledge of compass-laws and action now found to have become a necessity, when iron ships are the rule, and not the exception, as was the case some twenty years past. On the assumption that a measure of this nature must eventually obtain, I have appended a few short and simple rules (Appendix II.), which perhaps might be advantageously recommended by the authority of the Board of Trade, or Lloyd’s Register Committee.

“With reference to the second leading feature of the Admiralty system:—

“For many years in the Royal Navy the adjustment practised consisted in the careful selection of a place for the standard compass, and the formation of a Table of Errors by the process of swinging the ship; and this proved sufficient so long as the deviations were moderate in amount.

“In many recent iron-built and iron-plated ships the amount of deviation is, however, so large that the employment of magnets to reduce the amount of deviation has become unavoidable; but the correction by magnets, however perfect it may be, is not considered in the Royal Navy as superseding the obtaining a Table of Errors and navigating the ship by that Table.

“The benefits which have been derived in the Royal Navy, both as regards the safety of ships, and the theoretical and practical knowledge of the subject we have thereby obtained, cannot, I think, be over-estimated; and I may add that I consider that no compass can be said to be ‘properly adjusted’ of which, whether compensated by magnets or not, a Table of Errors has not been obtained by the process of swinging the ship, and that Table examined by a competent person.

“Closely connected with the subject is that of the construction of the compass itself, as regards form and workmanship, magnetic power, and adjustment. This subject received much of the attention of the Committee I have referred to; and the result of their labours was the production of the ‘Admiralty Standard Compass,’ an instrument which has stood the test of twenty-five years’ use, with little modification introduced, and

which has been adopted in all countries which directed their attention to this subject.

“Although indirectly the introduction of this compass into the Royal Navy has been the cause of much improvement in the compasses of the Mercantile Marine, there is still room for improvement. At present much expense is incurred in matters which are merely ornamental, and in some cases prejudicial. Probably much advantage would be derived from a model compass being fixed upon, which at a moderate price would supply the Mercantile Marine with the great desideratum of a compass of sufficient delicacy and accuracy. Considering that a few notes relating to the efficient points of a compass may prove useful, these notes will be found as Appendix III.

“There are yet two features in the ‘Compass question’ which appear to me as being worthy of consideration in any system that may be contemplated for assimilating the practice of the Mercantile Marine to that of the Royal Navy. These are,—

“1st. As to the efficiency of those who engage to perform the adjustments.

“2nd. The periods for examining the adjustments.

“By constant practice, but without any very clear knowledge of the principles of magnetism, several skilful adjusters of compasses are to be found at some of the great mercantile ports. These ‘adjusters’ must, from their practice, be now well known to the Board of Trade Surveyors. The registration of their names, and of the firms employing them, either by the local Marine Boards or by Lloyd’s Committee, might be a desirable step to take as a preliminary measure.

“The arrangements for swinging ships, I have also heard, are either defective, or practically do not exist, at most of the mercantile ports; might not the Board of Trade Surveyors report upon the nature of existing arrangements, and the means generally adopted by the ‘adjusters?’

“As to the periods for examining the adjustments, the recommendations of the Liverpool Compass Committee (see page 40, 3rd Report, 1861) appear to me to fully meet the case, and have such an important bearing on the secure navigation of iron ships, that I gladly bring them again to notice.

“‘There appears sufficient reason for requiring that a new iron sailing ship or steamer should be swung immediately before each of the first two or three voyages; that all iron vessels should be swung immediately before the first voyage following any considerable amount of repair, whenever a change has been made in the position of the standard compass; when there is a change of Captain, unless the new Captain had charge of the vessel during the preceding voyage as Chief Officer.’

“In conclusion I must observe that the present state and prospects of the science and practice of the correction of the compass make it impossible to offer with confidence any complete set of suggestions as to the

system to be adopted in the Mercantile Marine. This could only be elaborated by careful and continued attention directed to the magnetic character of the ships of the Mercantile Marine, their compasses, and the capabilities of its officers; and I think it must be assumed that no system can be expected to be satisfactory which does not gradually develope itself under proper supervision.

“ I have the honour to be, &c.

(Signed)

“ FREDERICK JOHN EVANS,
Staff-Commander R.N.,
Chief Naval Assistant, in charge
of Magnetic Department.”

“ *The Hydrographer of the Admiralty.*”

APPENDIX I.

Extracted from the Queen's Regulations and the Admiralty Instructions for the government of Her Majesty's Naval Service.

“ No iron of any kind is to be placed nor suffered to remain within the distance of seven feet of the binnacle or standard compasses, when it is practicable, according to the size and construction of the vessel, to remove it; and mixed metal or copper is to be substituted for iron in the bolts, keys, and dowels, in the scarphs of beams, coamings, and head-ledges, and also the hoops of the gaffs and booms and belaying-pins which come within the distance of seven feet of the compasses.

“ The spindle and knees of the steering-wheels which come within the distance of seven feet of the compasses are also to be of mixed metal.

“ Iron tillers, which work forward from the rudder-head, are not to range within seven feet of the compasses; and in vessels which have iron tillers working abaft the rudder-head, the binnacles are to be placed as far forward from the wheel as may be convenient for the helmsman to steer by.

“ The boats' iron davits are to be placed as far as may be practicable and convenient from the compasses.

“ All vertical iron stanchions, such as those for the support of the deck, or for the awnings, &c., and likewise the arm-stands, are to be kept beyond the distance of *fourteen feet* from the compasses in use, so far as the size of the vessel will admit.

“ The binnacles for the steering-compasses are to be constructed upon a given plan, with tops made to take off; and in order to prevent improper materials from being deposited therein, they are not to be fitted with doors.

“ For the better preservation of the compasses, in every ship a closet is to be constructed in a dry place, sufficiently large for the reception of the ship's establishment of compasses, and it is to be appropriated to that purpose *exclusively*, the key being kept by the Masters; and in order that

the spare compass-cards may never be kept with poles of the same name nearest to each other, cases are supplied which will prevent the possibility of their being packed improperly.

“All ships are to be swung before sailing from the port where they fit out, and subsequently once in each year, for the purpose of ascertaining the errors of the compasses, also immediately on their arrival on a Foreign Station; or if there has been any great change in the ship’s geographical position since the errors were observed.”

APPENDIX II.

Suggested Rules relating to the Compasses of Iron Merchant Ships.

“1. It is deemed a necessary equipment for every iron ship to be fitted with a Standard or navigating compass, in addition to one or more compasses for the use of the helmsman.

“2. That so far as the requirements of the ship will permit, special arrangements be made in the course of construction for preparing a place for this compass.

“3. That the Steering-Compasses being subordinate in importance to the Standard Compass, less strict precautions are required for their position; but it would in all cases be desirable that these compasses (and of necessity the steering-wheel) should not be placed within half the breadth of the ship from the stern-post, rudder-head, and screw-well.

“4. The Standard Compass to be placed at such a height from the deck (not less in any case than five feet) as to command a clear view of the horizon above the bulwarks, and to be out of the way of the sails, booms, &c.

“5. In ships built with their heads *near the north*, the Standard Compass to be placed as *far forward* as the requirements of the ship will permit. In ships built with their heads *near the south*, this compass to be placed as near the stern as convenient, subject to the condition that it should not be within half the breadth of the ship from the rudder-head, stern-post, or screw-well.

“In ships built near east and west, this compass should not be placed near either extreme of the ship.

“6. The Standard Compass to be as far as possible, and not less than ten feet, *from the end* of any elongated mass of iron, especially if vertical, such as iron stanchions, capstan-spindles, steam- and stove-funnels, ventilating-shafts, &c.; and no iron, subject to occasional removal, should be placed within fifteen feet of the Standard Compass, either on the same deck or below it.

“7. The Standard Compass to be placed as far as possible from transverse iron bulkheads.

“8. It would be an extremely desirable arrangement for the deck imme-

diately below the Standard Compass *not* to be of iron, but to be filled up with wood for a space which may be called the compass platform. This space should not be of less width than a hatchway (4 to 6 feet), and of as great length fore and aft as convenient, but the length not to be less than the width. No transverse iron deckbeams to be under the platform, but if necessary fore-and-aft iron stringers, on which the transverse beams outside the wooden surface may abut.

“9. It would be a desirable arrangement, as far as could be carried out, that no masses of iron, such as boilers, tanks, bulkheads, should be placed immediately below the compass, or within 55° of the vertical line through the centre (the angle being drawn from the compass as centre to the centre of the mass).

“10. Where the Standard Compass is placed on a bridge, the foregoing requirements should be, as far as possible, complied with, the bridge should be of wood, and should not have iron stanchions, or rails (especially if covered with brass) within 10 feet.”

The following Rules are applicable to Steering-Compasses.

“1. Not to be within half the width of the ship from the stern-post, rudder-head, or screw-well.

“2. The spindle of the steering-wheel and the forward support in which it works, *not* to be of iron.

“3. Iron tillers working forward from the rudder-head not to range within six to seven feet of the steering-compass.

“4. Not to be near the upper (or lower) end of elongated masses of iron, especially if vertical, such as steam- and stove-funnels, capstan-spindles, &c., and to be as far as possible from any transverse iron bulk-head.”

Special Points for the consideration of the Naval Architect.

“1. When arrangements are made for the compasses to be placed in the after part of the ship, building the vessel head north would ensure exaggerated errors both when upright and heeling.

“With building-slips in a meridional direction, and with the above arrangements, it would be desirable to build the ship head to the south.

“2. Every iron ship after launching, and during the process of first equipment, should as much as possible be kept in a position opposite to that she occupied on the building-slip.”

APPENDIX III.

Notes relating to the efficient points of a Compass.

“1. The essential qualities of a good compass may be considered to embrace great sensibility and steadiness, with simplicity of construction. By

sensibility and steadiness it is to be understood that the needle is freely to submit to the earth's magnetic force, with power sufficient to steadily obey that force under the varying motions of a ship, without the aid of friction or mechanical impediment, steadiness or rather sluggishness produced by the latter causes being obtained at the expense of accuracy.

"Simplicity of construction, so that repairs can be effected by an ordinary skilled mechanic, must be deemed a qualification of merit.

"2. The chief points to be attended to in construction are,—

"(a) Great directive power of the needle, with little weight, and consequently little friction on the point of suspension.

"(b) Permanency of the magnetic power of the needle.

"(c) Accurate adjustment of the several parts of the compass.

This comprises (1) the magnetic axis of the needle coinciding with the north and south points of the card. (2) The intersecting point of the axes of the jimbals of the bowl coinciding with the point of suspension of the card. (3) The accurate centering of the point of suspension within the bowl. (4) The perfect impression of the card, so that the centering and marginal divisions are not distorted by shrinking or other causes.

"3. The advantages of a compound system of needles compared with a single needle.

"These are, (1) greater directive power being obtained with the same weight. (2) The needles can be placed on their edge, whereby there can be no alteration of their magnetic axes, a condition frequently found in flat bar needles. (3) By placing one (or two) pairs of equal parallel needles with their ends 60° (or 30°) apart, the 'wabbling' motion common to single bar needles is avoided; and the following remarkable property also exists with this arrangement of the needles:—

"When magnets or soft iron are placed as correctors of the larger deviations due to the iron of the ship, unless the needle (where a single bar is employed) be very short compared to the distance of the disturbing magnet or iron, a deviation is introduced depending on the length of the needle. This deviation disappears with the compound arrangement.

"Proceeding from general principles to details, the following are the chief points to be attended to in the construction of a Standard Compass.

"1. The bowl to be constructed of *pure* copper, of substantial thickness, and the part adjacent to the needle increased in solidity, by an extra copper ring, the ends of the needle being permitted to work as close to the ring as consistent with freedom of motion.

"2. The needles to be fitted on the compound system (one pair to be deemed sufficient), and efficiently tempered and magnetized.

"3. The sight-vane to be arranged so as to turn freely in azimuth without moving the compass-bowl or causing disturbance to the card. It should be attached to a graduated circle, so as to show the angle between the ship's head and any celestial object as measured on the horizon without

using the compass-card. The sight-vane and graduated circle to be attached to the bowl.

"4. To be provided with one spare card, two spare caps, and four spare pivots.

"5. The caps to be fitted with rubies instead of agates. The pivots to be of steel hardened and tempered to a dark straw-colour."

*Letter No. 1, from the President to Mr. Farrer, transmitting
Memorandum.*

"Burlington House, Nov. 2, 1865.

"SIR,—I have now laid before the Council of the Royal Society your letter of the 25th of July, referring to the adjustment of the compasses of iron ships, and a copy of my letter of the 28th of August, acknowledging its receipt and adverting to the inquiry you had made as to the preparation of a 'Manual' on the subject, together with your subsequent letter of October 23rd, having reference to the same inquiry.

"The President and Council are much disappointed by learning that the Board of Trade are not prepared to give effect to the recommendation that the system which has been found to work so successfully in the Royal Navy, of combining official and competent superintendence with a proper code of instruction, should be extended to the Mercantile Marine. They consider such superintendence to be essential, not only to the general introduction of a good and efficient mode of compass-correction into the Mercantile Marine, but even to the discharge of the duties having respect to the adjustment of the compasses of sea-going passenger-steamers with which the Board of Trade is already charged by the Legislature.

"In the Memorandum accompanying my letter of the 15th of May, it was stated that many recent losses of iron steamers have taken place in which it is probable that compass-errors have occasioned the loss. The President and Council think it right to call the attention of the Board of Trade to the serious responsibility they incur in cases of loss of life and property arising from the want of a proper system of compass-adjustment, by declining to take the course which is pointed out by the concurrent opinion of all competent advisers, as not only the best, but the only method of securing the introduction of such a system. They cannot but look forward to a time when the necessity of a proper supervision will be forced on the executive by public feeling, excited by some disastrous loss of human life traceable to the want of such superintendence. The question is one which they feel to be of such vital importance, that they desire to submit to the consideration of the Board of Trade the accompanying Memorandum, replying in some detail to passages in your letter of July 25th, and which makes it unnecessary to me to dwell further on the subject.

"I have the honour to be,

"Your obedient Servant,

"EDWARD SABINE,

"President of the Royal Society."

Memorandum.

“The letter of the Secretary of the Marine Department of the Board of Trade of the 25th of July, to the President, conveying the views of the Board of Trade on the President’s letter of the 25th of May, and the Memorandum which accompanied it, seem to require some detailed observations.

“To obviate the risk of misapprehension of the scope and object of the Memorandum, it appears advisable to state that the main object which the President and Council had in view, was not to suggest that the objects desired might be obtained by framing definite and positive rules and enforcing their observance by penalties, but primarily to show the importance of some superintendence of the adjustment of the compasses, of at least one important class of iron vessels, being entrusted to a department specially constituted for the purpose, and to point out some of the advantages which might be expected to flow directly and indirectly from such a department. The appointment of an officer, with proper assistants, for the purpose indicated, is not, it is apprehended, beyond the existing powers of the Board of Trade, and would not, it is conceived, violate any sound principle of political economy.

“The President and Council believe that, in considering the appointment of such an officer a matter of paramount importance, they are supported by the judgment of the persons most competent to form an independent opinion. They have in the former Memorandum referred to the opinion expressed by the Liverpool Compass Committee. Since that Memorandum was submitted to the Board of Trade, the Council have found that a similar opinion was expressed so long ago as the year 1839, by the Astronomer Royal, who then addressed to the Admiralty a Memorial of a formal character, of which one of the conclusions was,—

“‘That it is expedient that the general superintendence of the compass in iron ships, for several years at least, be entrusted to some person appointed by the Government.’

“The Admiralty declined to appoint such an officer for the Mercantile Marine; but the very system recommended was introduced shortly afterwards into the Royal Navy, where experience has shown the very great advantages to be derived from it, and that in a service in which, if anywhere, obedience to positive rules without the intervention of a superintendent might have been supposed attainable. The Astronomer Royal has recently expressed his adherence to the opinion so expressed by him.

“The President and Council in the former Memorandum ventured to call attention to the duties in respect of the adjustment of the compasses of sea-going passenger-steamers, imposed by the Legislature on the Board of Trade, and to the imperfect mode in which those duties are at present discharged.

“The Board of Trade in its answer recognizes the importance of the subject, and admits that ‘the present practice is far from satisfactory,’ and that ‘the steps taken by the Board of Trade under the provisions of existing Acts are not such as to remedy the evil;’ but states that the Board see considerable difficulty in adopting all the suggestions made by the Royal Society.

“The difficulties are stated to be,—

“‘1. That the powers under which the Board acts apply only to passenger-steamers, while the want which the Royal Society wish to meet is felt just as much in the case of other iron vessels, which are becoming more numerous every day.

“‘2. That the powers of the Board of Trade only extend to obtaining a Certificate that the compasses have been properly adjusted. They do not enable the Board of Trade or its officers to see that the compasses are good, or to require, what the Royal Society appear to consider the most important condition of all, that there should be a Standard Compass (in addition to the Steering-Compass) so placed as to be free from local attraction.’

“With regard to the first of these difficulties, it cannot be necessary to suggest that the want of power as regards one class of vessels is no reason for not exercising the powers and discharging the duties of the Board as to another class of vessels. There are, however, other considerations which tend to show that it is not necessary to wait for extended powers. In the first place, on the establishment of a new department having new duties, there are some advantages in those duties being confined to a limited number of vessels. Again, all the indirect, and these not the least, advantages to be derived from such a department extend as much to vessels which do not come within the direct operation of the department as to those which do; and lastly, Shipowners and Underwriters, when the advantages of the department have been ascertained, may cause a voluntary submission of many vessels to the supervision of the Department.

“It is thus quite possible that experience may show that it is not necessary to obtain any legislative extension of the class of vessels to which the authority of the Board of Trade extends. If, on the other hand, it shall hereafter appear desirable to extend it, it is not to be anticipated that the Legislature will refuse to give extended powers.

“With regard to the second difficulty, it may be observed that the Board of Trade appear to put an unnecessarily restricted interpretation on the expression ‘compasses properly adjusted’ in the Merchant Shipping Act, 1854, Sec. 301.

“It is submitted with confidence that the expression in question enables and requires the Board of Trade and its Officers to see that one compass at least shall be in a position in which it is capable of being properly adjusted—a condition not generally consistent with its being the Steering-Compass—and therefore to require a special Certificate in the case of any Shipowner insisting on sending his ship to sea with only one com-

pass, or in which the navigating-compass does not fulfil the conditions prescribed. The information which the Council possess induces them to think that, under the present system, a large number even of sea-going passenger-steamers cannot be said to have their compasses 'properly adjusted'—and that owing to the causes pointed out in the 'Memorandum.' The President and Council do not apprehend that if the department recommended were established, its action would be impeded for want of authority.

"The President and Council therefore consider that even for the due discharge of the duties already imposed on the Board of Trade by the Legislature, some systematic superintendence on the part of the Board is necessary.

"With regard to the offer of the Board of Trade to communicate to Lloyd's Register Committee any practical rules which the Royal Society can furnish as to the supply, placing, and adjustment of compasses, and as to the effect on them of different modes of construction of the hull of the ship, the Board of Trade may be referred to the very valuable paper by Staff-Commander Evans, the Superintendent of the Compass Department of the Royal Navy, in answer to an application of the Board of Trade to the Admiralty, as containing everything which the President and Council could venture to suggest. The whole of this paper is well worthy of the most careful consideration; but there are some passages in it which bear so directly on the present subject, that they may be more specifically mentioned. In one of these Captain Evans states that the rule of navigating a ship by a standard compass is in itself so simple, has proved in practice so secure, and the neglect of it in many cases in merchant ships has been followed by such disastrous consequences, that he considers there is no question that it should be enforced, wherever there are the means of enforcement. In another passage Captain Evans states that he considers that no compass can be said to be 'properly adjusted,' of which, whether corrected by magnets or not, a table of errors has not been obtained by the process of swinging the ship, and that table examined by a competent person. In a third passage Captain Evans observes that the present state and prospects of the science and practice of the correction of the compass makes it impossible to offer with confidence any complete set of suggestions as to the system to be adopted in the Mercantile Marine; this could only be elaborated by careful and continued attention directed to the magnetic character of the ships of the Mercantile Marine, their compasses, and the capabilities of its officers; and that he thinks it must be assumed that no system can be expected to be satisfactory which does not gradually develop itself under proper supervision. They trust that the communication of this important paper to Lloyd's and its publication may be followed by beneficial results.

"The Board of Trade further say that, as regards the diffusion of information on the subject of compasses, especially among Merchant

Officers, the first desideratum appears to be a clear and intelligible manual, or set of directions on the subject containing such practical rules as the present state of Science can furnish, and such a statement of the principles as may be necessary for the comprehension of those rules; and inquire whether the Royal Society can put them in the way of obtaining such a manual, stating that any expense connected with its preparation will be readily defrayed by the Board of Trade.

“The President and Council do not consider the manual to be the *first* desideratum, but, on the contrary, they consider that, so long as the present system continues, such a manual would have a very limited and partial use. It will be remembered that in the Memorandum the Council itself suggested, as part of the general scheme proposed, that notice might be given that after a certain period, say two or three years, a certain amount of knowledge will be required from Candidates, and that in the meantime a text-book containing the necessary amount of information might be prepared and published; and they conceive it would be one of the earliest duties of the proposed department to cause such a text-book to be prepared; but the President and Council conceive that it would be premature to prepare it until the system to be pursued has been decided on, and without the concurrence of the person to be charged with carrying it into effect.

“As regards introducing the subject of the deviation of the compass into Examinations in Navigation, the President and Council will be happy to give any information or assistance in their power. They feel, however, as in the case of the text-book they have referred to, that such examination should follow, not precede the appointment of a Superintendent, and should be under his direction.

“As regards inquiries into the causes of wrecks, the Council are happy to find that the Board of Trade are disposed to take some step in the direction indicated in the Memorandum.

“In the former Memorandum attention was called to the importance, as regards the advancement of the science of the deviation of the compass, of observations of the deviations of the same compass in the same ship at different times and places being made and systematically reduced and discussed. Trustworthy observations of this kind are now among the principal desiderata in this science. As regards such observations, the Board of Trade state that all they can do is to obtain observations from Masters of Merchant ships in the manner originally proposed by the Royal Society when the Meteorological Department of that office was established, and that the subject will come under the consideration of the Board, with the whole subject of the Meteorological Department.

“The proposal made by the Royal Society in the year 1855, in con-

nexion with the Meteorological Department, had reference to Terrestrial Magnetism, not to the deviations of Iron Ships; and they would observe, as regards any observations of such deviations, that the whole scientific value of such observations depends on their being made in strict conformity with corresponding observations made in the same vessel, and under the same precise conditions at home. No such conformity can be expected or ensured unless with some system of supervision. It may be further observed that the value of such observations depends on the compass by which the observations are made being one fulfilling the conditions recommended with reference to the navigating-compass. For the Meteorological Department to obtain and deal with such observations it would be necessary that it should possess an Officer qualified to discharge, and discharging, many of the duties of such a Superintendent as is recommended by the Council. Finally it may be observed that Shipmasters cannot be expected to make or transmit such observations, unless encouraged so to do, by knowing that the observations when made have a real value, and that they will be appreciated, made use of, and publicly acknowledged."

Letter No. 2, from the President to Mr. Farrer.

"Burlington House, Nov. 2, 1865.

"SIR,—I have laid before the Council of the Royal Society your Letter of the 24th of October, in reference to the Meteorological Department, and am authorized to make the following reply:—

"The President and Council fully concur with the Board of Trade regarding the importance of inquiries being made into the value of the observations obtained at sea under the direction and guidance of the Meteorological Department of the Board of Trade, and into the steps which should be taken to utilize the results, as well as the importance of the further question, whether any, and, if any, what future observations of the same or of a similar kind bearing on Ocean Statistics should be collected. They will be quite ready to assist in this inquiry in the manner proposed, viz. by nominating one of their Fellows conversant with such subjects, as a member of the proposed Committee*.

"In reference to the last paragraph of your letter of the 24th October, they are of opinion that systematic meteorological observations at a few selected land stations in the British Islands are desirable, in addition to the meteorological observations at sea, in order to complete a suitable contribution from this country to the meteorological investigations now in progress in the principal States of Europe and America, under the authority of their respective Governments.

"If, in the communication from the Royal Society to the Board of Trade of February 22, 1855, which preceded the establishment of Admira

* [The Council nominated Mr. Francis Galton, F.R.S., to serve on the Committee referred to

FitzRoy's Office, the advantages to be derived from a continued and well-directed system of maritime observations were more particularly pressed, it was because at that time neither the instruments nor the modes of observation suitable for a well organized and efficient system of continuous land investigation were prepared. This was well stated by Lieut. Maury in a letter addressed to the United States Government, dated November 6, 1852, subsequently transmitted by that Government to the Earl of Clarendon, and printed in the papers which were presented to the House of Lords in February 1853. This difficulty no longer exists, having been entirely obviated by the self-recording system of observation for which the necessary instruments have been devised and brought into use at the Kew Observatory.

"The President and Council are not aware of any inconvenience likely to arise from entrusting the scientific supervision of such a system as they have recommended to a Body such as the Kew Committee, acting under the authorization, and control in regard to expenditure, of a Public Department. Precedents for such a course are not wanting.

"I have the honour to be

"Your obedient Servant,

"EDWARD SABINE,

"*President of the Royal Society.*"

From Mr. Farrer to General Sabine.

"Board of Trade, Whitehall, 14th November, 1865.

"SIR,—I am directed by the Board of Trade to acknowledge the receipt of your letter of the 2nd instant, stating that the President and Council of the Royal Society 'are much disappointed by learning that the Board of Trade are not prepared to give effect to the recommendation that the system which has been found to work so successfully in the Royal Navy, of combining official and competent superintendence with a proper code of instructions, should be extended to the Mercantile Marine. They consider such superintendence to be essential, not only to the general introduction of a good and efficient mode of compass-correction into the Mercantile Marine, but even to the discharge of the duties having respect to the adjustment of the compasses of sea-going passenger-steamers, with which the Board of Trade is already charged by the Legislature.'

"The President and Council further proceed to call attention to the losses of Iron Steamers, and intimate that the responsibility for such losses will rest with this Board if they do not undertake the superintendence of compasses in the mode suggested by the Royal Society.

"In reply I am to state to you, in the first place, that the Board of Trade do not yield to the President and Council of the Royal Society in their anxiety to prevent losses at sea, and they are ready with this object to do everything which is within the proper and legitimate scope of their functions as a Government department.

“What the scope of those functions is, and how they can be most usefully exercised, are questions on which they must form their own opinion, and they regret that the opinion they have thus formed is at variance with the views which the President and Council of the Royal Society have thought fit to urge.

“As regards the practice of the Admiralty to which you call attention, I am to point out in the first place, that there is a wide difference between the relation of the Board of Admiralty to Her Majesty’s Navy, and that of the Board of Trade to the Mercantile Marine. This difference appears to have been underrated, if not entirely overlooked by the President and Council of the Royal Society.

“The Admiralty are the owners, designers, and generally the builders of the Ships of the Nation, and in these capacities are bound to use every means in their power to construct the National Ships in the best manner, to provide them with the best equipments, and to dictate and enforce, upon all persons concerned in building, equipping or navigating them, such arrangements and regulations as the most advanced science and the latest experience can suggest. On the other hand, the Board of Trade are not the owners, designers, or builders of Merchant Ships; and if they were to take upon themselves the responsibility of regulating the construction of every Merchant Ship, and of requiring her to be provided with what might appear to this Board to be necessary and proper equipments, they would be usurping a power they do not possess, and which as a matter of policy they ought not to possess. They would in so doing be taking upon themselves a function which belongs to the shipowner, and which it is his interest, as well as his duty, to perform efficiently. It can be no part of the functions of Government to put a stop to the free and healthy action of that self-interest, or to relieve the shipowner and his servants from his responsibility for the performance of that duty.

“The result thus arising from Government interference would, the Board of Trade are satisfied, be injurious to trade in the first instance, whilst it would in the end be no less prejudicial to the safety of the public, and to the advancement of science.

“But if, looking to certain precedents, the President and Council of the Royal Society should still urge that in the special and exceptional case of deviation of ship’s compasses it is the duty of the Government to depart from the principles generally admitted in this country, the Board of Trade would reply that, so far as they can judge, the subject of compass-deviation is one which in its present condition is peculiarly unfit for legislative or administrative interference. Where a precautionary measure is capable of being reduced to fixed, simple, and intelligible rules of practice, it is possible, even though it may not be advisable, to enforce it by legal and administrative process. But this subject is, so far as the Board of Trade can judge, far from being in that condition.

“It appears from the papers submitted to the Board of Trade in this

case, that the causes of deviation of the compass in each individual ship are numerous and dissimilar, and their effects proportionately varied. In addition to the variety of effects due to the variety of causes, these effects seem also to vary according to the build of the ship, the nature and quality of the material of which she is built, and the direction of the line of the keel during building, the nature, quantity, and stowage of the cargo, the ship's course for the time being, her position in the water for the time being, the magnetic hemisphere in which she may be, and the varying distance of the ship from the magnetic equator. They vary, too, it would seem, from time to time, according to the service on which the ship may be or may have been employed, and with the age of the ship. Science has undoubtedly done much to ascertain the laws that govern these numerous causes of error; but it is obvious, even from the tentative and experimental process which the President and Council of the Royal Society themselves suggest, and from the difficulty they find in preparing the specific directions for which the Board of Trade have asked, that the remedy is not capable of being reduced to fixed or simple rules, or of being enforced without a large and experienced staff of scientific officers, or without an amount of minute arbitrary and indeterminate supervision which would be intolerable and impracticable. Moreover, so far as the Board of Trade can learn, the highest authorities are not yet agreed as to the principle of the remedy, the practice of the Admiralty, which receives the approval of the Royal Society, being founded in the main on one principle, whilst the practice of the Mercantile Marine is founded on another and different principle, which is supported by no less an authority than the Astronomer Royal.

"In a letter from the Admiralty to this Board, dated 14th September last, are enclosed some memoranda by Commander Evans, R.N., of the Compass Department. These memoranda the Royal Society indorse in the printed memorandum enclosed in their last letter. In them it is stated that the principal features of the system followed in Her Majesty's Navy are, '1. By having in each ship a standard compass distinct from the steering-compass * * * by which compass alone the ship is navigated,' and '2. The requiring each ship to be swung and to be navigated by a Table of Errors.'

"On the other hand, the Astronomer Royal, in his syllabus of a course of lectures delivered this year to the Royal School of Naval Architecture and Marine Engineering, states that he 'has no hesitation in giving his own opinion that the compasses used for directing the ship's course ought to be corrected, and that the efforts of scientific men ought to be directed mainly to the rendering this correction rigorously accurate and easy of application.'

"The Board of Trade have, as the President and Council of the Royal Society are aware, already published and circulated Mr. Towson's work, a work 'strongly recommended to nautical men' by the Astronomer Royal,

and approved by the Assistant Hydrographer; they are, as the Royal Society are also aware, prepared to print and circulate amongst all persons interested any practical hints or directions that the President and Council of the Royal Society, the Admiralty, or the Astronomer Royal may be able to furnish; and they are also prepared to procure the best scientific help upon investigation into wrecks in any case in which it may appear that a wreck may have been caused by compass-errors.

“But the Board of Trade, for the reason above stated, are not prepared to assume the responsibility which would be involved in appointing an officer or officers whose duty it should be to superintend the compasses of Merchant Ships, and to enforce upon shipowners and navigators compliance with what such officers may believe to be the latest requirements of science.

“In coming to this conclusion, the Board of Trade believe that they are doing what is most calculated to promote the free and healthy development of scientific results as applied to the Mercantile Marine, as well as to further what are their own proper objects, viz. the benefit of trade and the public safety.

“I have the honour to be, Sir,

“Your obedient Servant,

“T. H. FARRER.”

“*The President of the Royal Society,
Burlington House, Piccadilly.*”

[Pursuant to instruction, the Secretary acknowledged the reception of the above letter by the President and Council.]

From Sir J. Emerson Tennent to General Sabine.

“Office of Committee of Privy Council for Trade,
Whitehall, 20th November, 1865.

“SIR,—With reference to your letter of the 2nd November, stating the willingness of the President and Council of the Royal Society to appoint one of their Fellows to represent the Society upon a Committee to examine and report on questions connected with the Meteorological Department of the Board of Trade, I am directed by the Lords of the Committee of Privy Council for Trade to inform you that Staff-Commander Evans has been nominated by the Admiralty, and Mr. Farrer by this Board; and I am at the same time to request you to be good enough to forward the name of the gentleman selected by the President and Council of the Royal Society.

“The following are the points which the Board of Trade propose to refer to the Committee, if the President and Council see no objection.

“1. What are the data, especially as regards Meteorological Observations made at Sea, already collected by and now existing in the Meteorological Department of the Board of Trade?

"2. Whether any, and what steps should be taken for arranging, tabulating, publishing, or otherwise making use of such data.

"3. Whether it is desirable to continue Meteorological Observations at Sea; and if so, to what extent, and in what manner.

"4. Assuming that the system of Weather Telegraphy is to be continued, can the mode of carrying it on and of publishing the results be improved?

"5. What Staff will be necessary for the above purposes?

"I have the honour to be, Sir,

"Your obedient Servant,

"J. EMERSON TENNENT."

"*The President of the Royal Society.*"

[The President replied to this letter, and forwarded the name of Mr. Francis Galton, F.R.S., selected by the Council to be a Member of the Committee.]

December 7, 1865.

Dr. WILLIAM ALLEN MILLER, Treasurer and Vice-President,
in the Chair.

It was announced from the Chair that the President had appointed the following Members of the Council to be Vice-Presidents:—

The Treasurer.

Mr. Gassiot.

Sir Henry Holland.

Mr. Alfred Tennyson, Poet Laureate, and Mr. Robert Grant, were admitted into the Society.

The following communications were read:—

I. "Addition to the Memoir on Tschirnhausen's Transformation."

By ARTHUR CAYLEY, F.R.S. Received October 24, 1865.

(Abstract.)

In the memoir "On Tschirnhausen's Transformation," Phil. Trans. vol. clii. (1862) pp. 561–568, I considered the case of a quartic equation: viz. it was shown that the equation

$$(a, b, c, d, e \chi x, 1)^4 = 0$$

is, by the substitution

$$y = (ax + b)B + (ax^2 + 4bx + 3c)C + (ax^3 + 4bx^2 + 6cx + 3d)D,$$

transformed into

$$(1, 0, \mathfrak{C}, \mathfrak{D}, \mathfrak{E} \chi y, 1)^4 = 0,$$

where $(\mathfrak{C}, \mathfrak{D}, \mathfrak{E})$ have certain given values. It was further remarked that $(\mathfrak{C}, \mathfrak{D}, \mathfrak{E})$ were expressible in terms of U', H', Φ' , invariants of the two forms $(a, b, c, d, e \chi X, Y)^4$, $(B, C, D \chi Y, -X)^2$, of I, J, the invariants